Space Weather Technical Forecast

Issued on Thursday, 18 January 2024 at 12:02 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Now-reduced daily Chance of isolated M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity measured by GOES16 was Low over the last 24 hours. Occasional low to mid-ranking C-class flares were observed, peaking with a C5.4 at 18/0408UTC from AR3553, a Csi/Beta just east of centre-disc.

There were up to nine sunspot regions on the disc as of the current UTC morning, with two unnumbered regions rotating into view over the eastern solar horizon. The main changes in the period have otherwise been the development of intermediate spots within AR3555 such that is now assessed as a Dsi/Beta. The tenuous Mt Wilson delta spot in AR3553 has now faded, with the penumbrae surrounding the trailers breaking apart to leave a Csi/Beta. AR3545 showed an areal decrease and the fading of minor spots surrounding the main penumbra, while AR3549 near south-centre disc showed a minor reconfiguration of its diffuse small trailing spots.

While some minor Coronal Mass Ejections (CMEs) were visible on Lasco C2 imagery in the past 24 hours, none of these are though to bear Earth-directed components.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR, were within Background levels, however the prevailing slow regime did show characteristics of a minor enhancement after 18/0300UTC.

The cause of this enhancement is uncertain - in part because the hitherto more reliable ACE data is episodic, while the more available DSCOVR data is periodically appearing suspect. For discussion on the causes of current solar wind characteristics please see the 'Geomagnetic Storms' section.

The IMF increased from background to a Slightly Elevated peak of 8nT after 18/0300UTC, with the north-south component varying between +4 and -6nT. The solar wind speed showed an initial slight waning tendency from 350 to 300km/s before regaining and surpassing lost ground after 18/0300UTC to reach 375km/s by the period's end. The solar wind density was within single figures ppcc through this change. The phi angle was mainly negative prior to 17/1900UTC, but underwent a change to positive thereafter that began to drift in the current UTC morning.

The net result of the above solar wind measures was nevertheless provisionally Quiet Kp indices throughout.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at Background levels.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background levels. The

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associated 24-hour fluence was well below Active (1e8 integrated pfu) on a steady trend. The 18/0001UTC 24-hour integrated fluence observation was 1.37e6 integrated pfu.

Four-Day Space Weather Forecast Summary

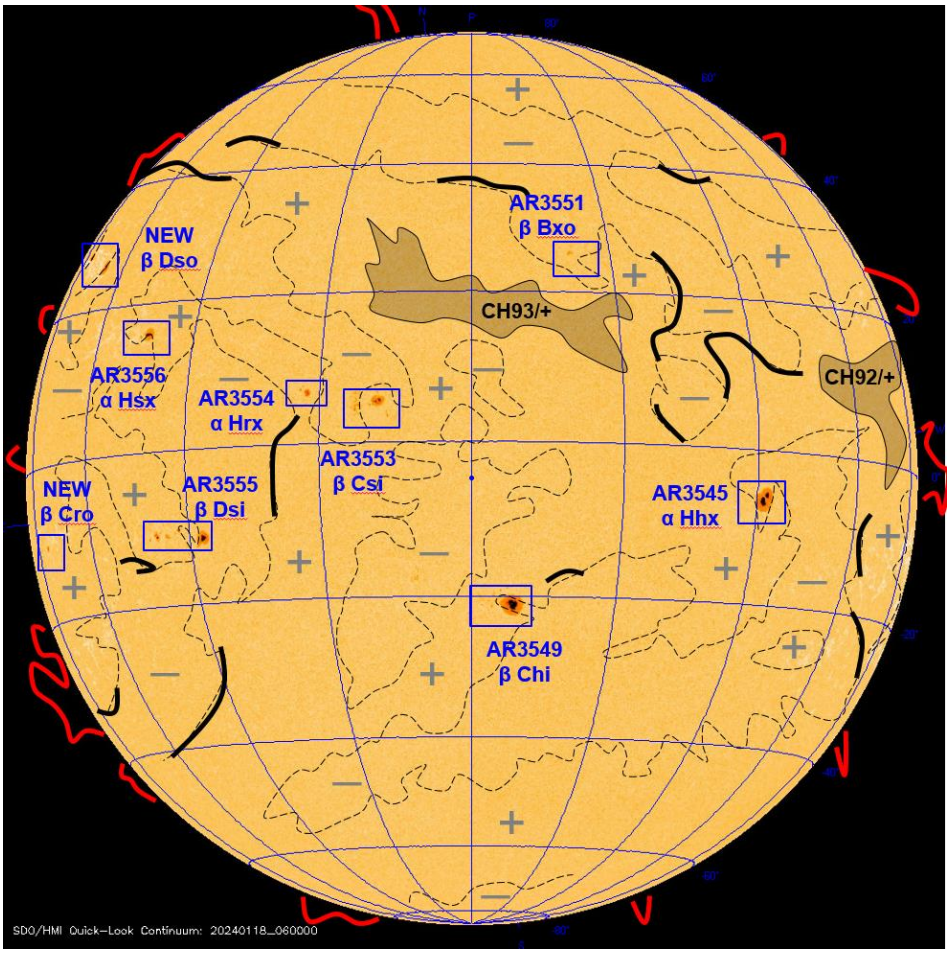
Solar Activity: There is a now-reduced daily Chance of Moderate X-ray activity.

Solar Wind / Geomagnetic Activity: No CMEs feature in the forecast. There is perhaps one remaining stream of fast wind in the forecast, that from CH93 which remains posited for Saturday 20 January arrival. Mainly Quiet geomagnetic activity is expected through the tail of the UTC working week, perhaps increasing to a Slight Chance of G1 on Saturday 20 January, waning over the remainder of the weekend.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to remain at Background levels, with a daily Slight Chance of radiation storms occurring.

The high energy electron flux is likely to be at Normal Background levels, perhaps rising late in the period. Despite any rise, the associated fluence is expected to remain below the Active threshold throughout.

Figure 1. Solar Analysis Valid 18/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs currently feature in forecast.

As regards fast winds, CH92 is either very late or has occurred and was very muted. CH93 is likely to be more notable, and is still most likely due on Saturday 20 January.

Recent solar wind measures present a puzzle, however the upshot on geomagnetic activity has been inconsequential. The cause of the 18/0300UTC enhancement is uncertain, but may yet evolve into a clearer example of the two hypotheses with time.

The two schools of thought are that the disturbance is either: firstly, an un-forecast transient, with the magnitude of the IMF jumping to 8nT and then showing relatively smooth sweeps through Bx, By and Bz components in the ensuing hours, in addition to a drifting phi angle. Secondly, this could be a coronal hole, with the solar wind speed showing a gradual rise, with the density very slightly reducing within single figures ppcc and the proton temperature remaining relatively high after onset.

Assuming a purely radially-emanating solar wind from CH92, the speed would have to be around 300km/s at Earth to reach the planet today (for a coronal hole leading edge in excess of 70 West). This is considered borderline unphysical for a coronal hole, and either a fast wind angled eastwards relative to its emission longitude would have to be invoked (i.e. sub-radial), or else perhaps the more likely scenario that a minor fast wind has already occurred through the current UTC working week, and has not been diagnosed in the L1 satellite noise. Whatever the mechanism, the enhancement is not expected to approach G1, and the probabilities of such activity occurring have been removed from the forecast, with occasional Unsettled intervals now favoured.

A further fast wind enhancement, and Slightly Elevated speeds, remains possible from CH93/+ on Saturday 20 January. This is a northern solar hemisphere feature and carries a chance of passing above the ecliptic plane. MOSWOC Enlil is suggesting a general increase in wind speeds through this period up to 500-550 km/s, which is considered likely to be overdone at this time. This coronal hole is positive polarity, which is becoming less favoured for geomagnetic response at this time of year.

Overall, mainly Quiet geomagnetic activity is expected through the tail of the UTC working week, perhaps increasing to a Slight Chance of G1 on Saturday 20 January in the arriving fast wind regime from CH93, waning over the remainder of the weekend.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

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Nil.

Figure 2: L1 solar wind over the past 24 hours as recorded by DSCOVR and ACE, with the period after the 18/0300UTC disturbance shown boxed in red. The idealised behavuiour of the CME-like traits are then shown in the image to the right, i.e. gradual transitions between orientations of phi and the B-field components.

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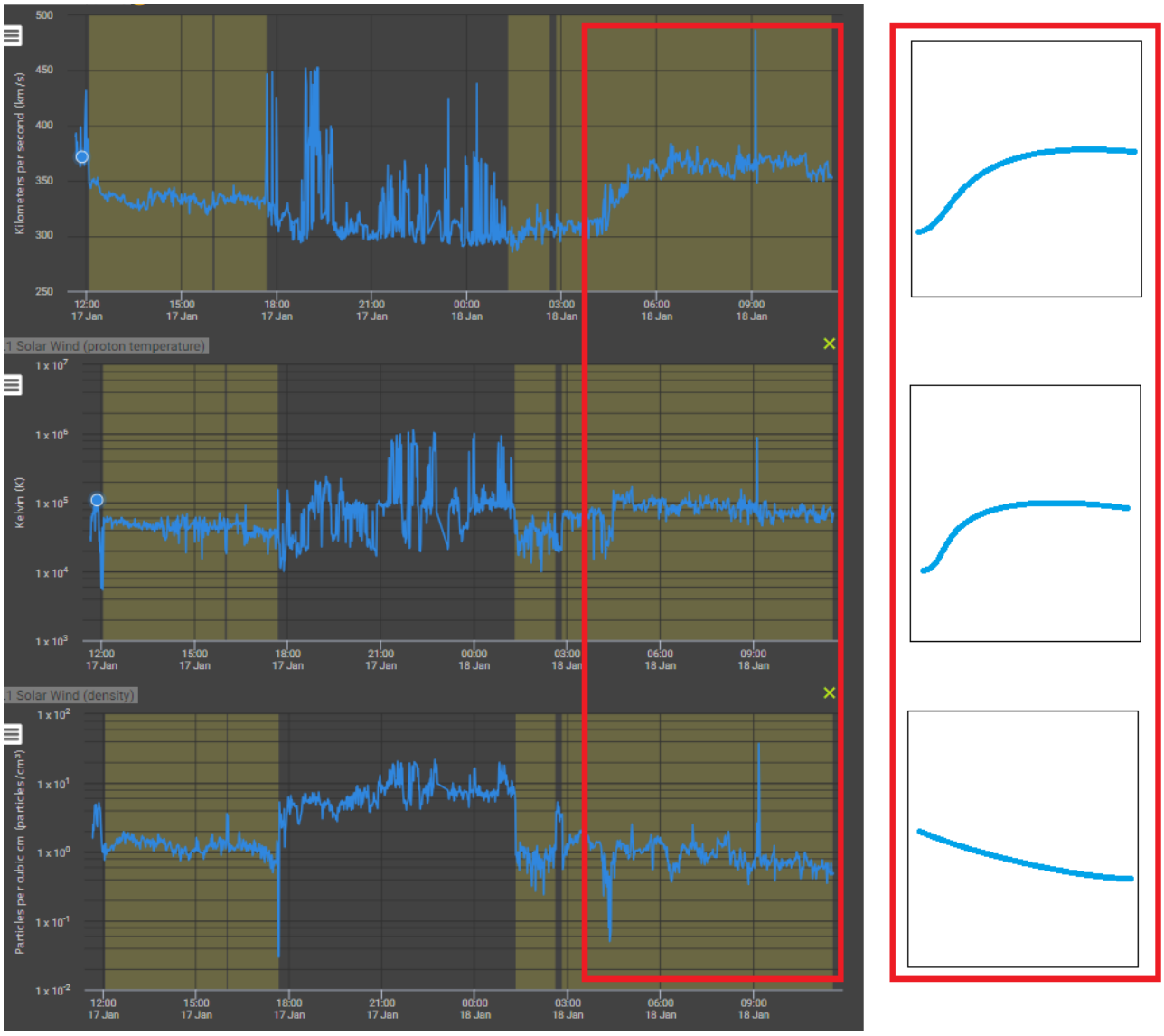
Figure 3: Some of the more corona hole-like traits for the same feature: respectively ACE solar wind speed, proton temperature and density.



Radio Blackouts - X-Ray Flares:

No significant returning regions are due from expected returning Carrington locations in the four days, with the possible sole exception of Ex-3534 in the southern solar hemisphere over the coming UTC weekend. None of the more significant front-sided groups leave in the same interval, although AR3545, an Hhx should lie on the limb on Sunday 21 January. These factors therefore lend themselves to a roughly level tendency for significant flares when considered as a whole.

In addition to the above, because of the dearth of recent activity as well as the observation that the Penticton 10.7cm flux is now entering a similar accelerating decline that it showed on last rotation, a blanket slight decrease in risk has been applied to all days of the period relative to recent guidance.

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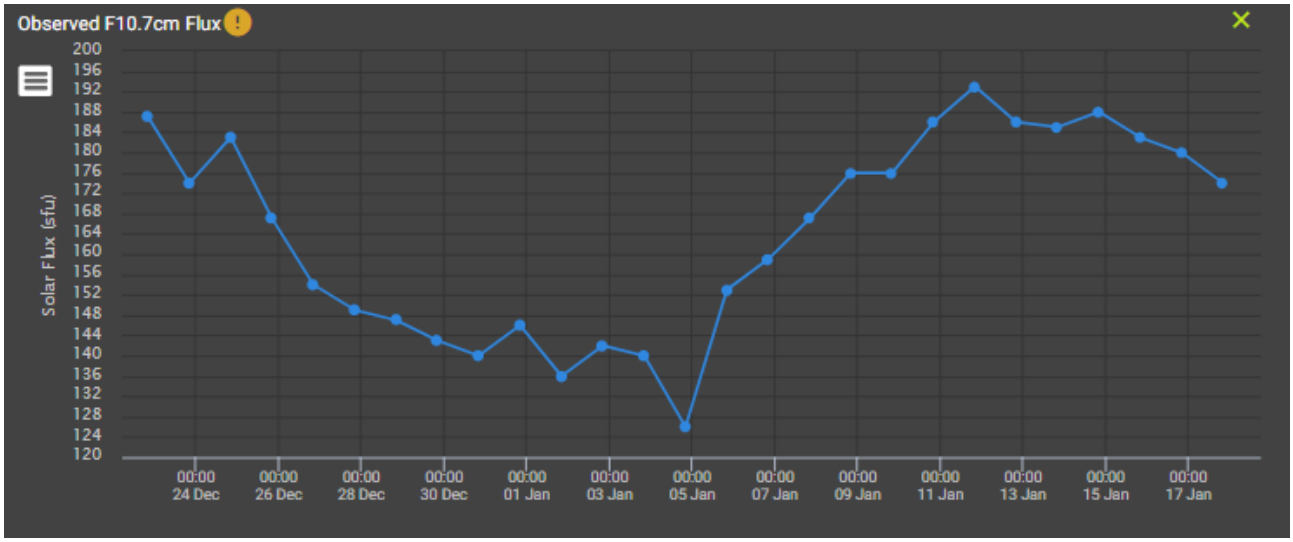
Figure 4: Penticton 10.7cm flux 27-day tendency, showing the possible beginnings of a descent into a period with fewer, less potent sunspot regions.



As for the trend, the strength of the 'regression to the mean' risk of moderate X-ray flares (around 40% for the current part of the cycle) is similarly also now muted on the expectation that there is a correlation between the falling Penticton value and the side of the Sun that presents itself through this period.

All considered, solar activity should see a damped daily Chance of increasing to Moderate, although the hint of a very gradual increase towards 'climatology' over the four days is maintained.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

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Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently at Background levels and expected to remain so through the period, with no complex sunspots currently in favourably-connecting parts of the disc, and no recent significant flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as measured by GOES16 at GEO is currently at Normal Background levels. Given the now very late or very muted fast wind response from CH92, no drivers to influence electron populations are now expected until after CH93, which would put any eventual response in fluence at the very tail end of the forecast into Sunday 21 January.

While no CMEs feature in the forecast, it is day four that is expected to see any departure from the current very subdued electron counts at GEO - i.e. beyond REFM's range of 72 hours. The current forecast of a continuation of quiet conditions is accepted in the mean-time, with REFM's thoughts on CH93 awaited.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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